effects. Touchscreen **11** may sense touches using any sensing technology, including capacitive sensing, resistive sensing, surface acoustic wave sensing, pressure sensing, optical sensing, etc. Touchscreen **11** can sense multi-touch contacts and is capable of distinguishing multiple touches that occur at the same time. Touchscreen **11** may further display images for the user to interact with, such as keys, dials, etc., or may be a touchpad with minimal or no images.

[0015] Although the embodiment of FIG. **1** is a cellular telephone **10**, other embodiments may be any type of device that includes one or more touchscreens that is capable of accommodating multi-touch. The generally simultaneous or concurrent multiple touches may occur on a single touchscreen, or may occur on two different touchscreens at the same time. The touches may be from a user's finger, a stylus, or from any other object.

[0016] FIG. **2** is a block diagram of touchscreen **11** and indicates two contact points **31**, **32** where a multi-touch contact has occurred. In one embodiment, processor **12** generates dynamic haptic effects based on a number of possible factors associated with contact points **31** and **32**. For example, the haptic effects may be based, at least in part, by the distance between contact points, the direction of motion of the contact points, the number of contact points (e.g., if there are more than two contact points), the screen position of the contact points, the function being initiated by the contact points, the amount of pressure being applied at each contact point, etc.

[0017] FIG. **3** is a flow diagram of the functionality performed by telephone **10** of FIG. **1** in response to multi-touch contact on touchscreen **11**. In one embodiment, the functionality of FIG. **3** is implemented by software stored in memory and executed by a processor **12**. In other embodiments, the functionality can be performed by hardware, or any combination of hardware and software.

[0018] At **102**, the multi-touch contact is sensed and the position each contact point and the number of contact points is determined.

[0019] At **104**, a dynamic haptic effect is calculated based the position and number of contact points, and based on any number of other factors such as the factors disclosed above (e.g., distance between points, direction of motion of points, etc.). The haptic effect is dynamic in that one or more parameters such as amplitude, vibration, frequency, etc. are varied over time. The dynamic nature of the haptic effect provides additional information to the user in contrast to static haptic effects. The need to provide additional information increases as two or more generally simultaneously touches are sensed on a multi-touch device. In one embodiment, multiple dynamic haptic effects may be calculated, one for each contact point, so that each contact object (e.g., each finger) may experience a different haptic effect rather than a single dynamic haptic effect that is applied to the entire telephone **10** or touchscreen **11**.

[0020] At **106**, the calculated dynamic haptic effect at **104** is output to drive circuit **16** and actuator **18** so that the effect is implemented in the form of vibrations or other haptics.

[0021] In operation, embodiments creates dynamic haptic effects in response to multi-touch contacts to enhance the functionality and usability of telephone **10**. For example, when the multi-touch contacts are two or more fingers, a user may be able to move their fingers apart while touching or in close proximity to touchscreen **11** in order to zoom in on a displayed image. In response, a dynamic haptic effect can be generated that increases in amplitude or frequency to communicate the sensation of a growing or increasing virtual window or object size and/or volume. The action of bringing the fingers back together can result in an equal and opposite decreasing amplitude or frequency to communicate the sensation of a shrinking or decreasing virtual window or object size and/or volume.

[0022] In another example, two or more fingers may be moved apart for the purpose of moving through a displayed list of contacts, text, or menu items and in response a dynamic haptic effect of increasing amplitude or frequency may be generated that is based on the distance between the finger points. The further apart the user's fingers are, the greater the amplitude or frequency of the haptic effects would be in order to communicate the sensation of increasing speed or movement through the list of contacts or menu items. The action of bringing the fingers back together would result in an equal and opposite decreasing amplitude, or frequency to communicate the sensation of a decreasing speed or movement through the list of contacts or menu items.

[0023] Further, two or more fingers can make a rotating gesture equivalent to turning a virtual knob on touchscreen **11**. In response, dynamic haptic effects can be generated as the virtual knob is turned to simulate those sensations felt in turning a mechanical knob such as detents and barriers. Other dynamic effects can be generated that are not typically associated with a rotary knob but provide information such as scroll-rate control, end-of-list/top-of-list notifications, etc.

[0024] In another embodiment, two or more fingers may set a boundary box (selection area) that allows the user to interact with all virtual grasped items contained in the bounded box. While sliding the bounded box, dynamic haptic effects may generate a sliding feeling and can vary depending on the speed of the dragging or how far the box is being dragged. Further, the interaction of resizing the items by increasing or decreasing the distance between two fingers may generate an equivalent dynamic haptic effect of increasing or decreasing amplitude or frequency, or a haptic effect of consistent amplitude and frequency that communicates the action of relative increasing or decreasing object sizes. Further, the interaction of rotating the grasped items by rotating fingers clockwise or counter-clockwise may generate an equivalent dynamic haptic event of increasing or decreasing haptic amplitude or frequency, or a haptic effect of consistent amplitude and frequency that communicates the action of rotating the object (s) away from their initial starting location or virtual setting. Further, the interaction of dragging the items by moving the fingers across the screen may generate an equivalent dynamic haptic effect of increasing or decreasing haptic amplitude or frequency, or a haptic effect of consistent amplitude and frequency that communicates the action of physically dragging the object(s) away from their initial starting location or virtual setting.

[0025] In another embodiment, telephone **10** includes a foot pedal or switch so that a user can use one foot to control a pedal button/switch while manipulating a touchscreen to interact with virtual objects. In one embodiment, the foot pedal's button action could be used in the same way a mouse button click could be used for anchoring a cursor point. The user's hands would then be free to manipulate a touchscreen and performing functions such as activating, navigating, resizing, reshaping, moving, combining of menus, menu items, windows, virtual shapes or virtual objects. Each of these interactions could have a dynamic haptic effect triggered at the same time to better communicate these interac-